

TABLE OF CONTENTS

1.0	IBC Chapter 16 Structural Design	3
1.1	Section 1601.1 Scope.....	3
1.2	Section 1607 Live Loads.....	3
1.3	Section 1608 Snow Loads.....	4
1.4	Section 1609 Wind Loads	4
1.5	Section 1612 Flood Loads.....	4
1.6	Section 1613 Earthquake Loads	5
1.7	Add Section 1616 Accidental Blast Loads	8
1.8	Add Section 1617 Minimum Antiterrorism Structural Design Measures	8
2.0	IBC Chapter 17 Special Inspections and tests	9
3.0	IBC Chapter 18 Soils and Foundations.....	9
3.1	Section 1803 Geotechnical Investigations	9
3.2	Section 1808 Foundations	9
3.3	Section 1809 Shallow Foundations	9
4.0	IBC Chapter 19 Concrete	9
4.1	Section 1901 General.....	9
4.2	Section 1904 Durability Requirements	10
5.0	IBC Chapter 20 Aluminum.....	10
6.0	IBC Chapter 21 Masonry	10
7.0	IBC Chapter 22 Steel	11
8.0	IBC Chapter 23 Wood.....	11
9.0	IBC CHAPTER 31 SPECIAL CONSTRUCTION.....	11
10.0	RECORD OF REVISIONS	12
Appendix A – Anchorage to Concrete and Masonry		14
A.1	Description.....	14
A.2	Applicable Codes	14
A.3	Applicable Industry Standards and Reports (Requirement 5-0091)	14
A.4	LANL Documents	14
A.5	Prerequisites for Determining Anchor Design Loads	15
A.6	Environmental Conditions	16
A.7	Seismically Exempt Anchors.....	16
A.8	Power-Actuated Fasteners.....	16
A.9	Grouted Reinforcing steel	16
A.10	Requirements for Transfer of Shear Load to Foundations	16
A.11	General Design Requirements.....	17
A.12	Design Requirements.....	17
A.13	Drawing Requirements.....	18
A.14	Recommended Methodology for Seismic Design of Anchorage to Concrete or Masonry for Nonstructural Components	19
Appendix B – Design Approach to Commercially Fabricated Buildings used in Multi-State Jurisdictions ...		21
Appendix C – Restraint of Non-Facility (e.g., Programmatic) Equipment.....		22

SECTION II- COMMERCIAL DESIGN & ANALYSIS REQUIREMENTS

New in this revision (older revisions addressed in 10.0 Record of Revisions)

Adopted DOE O 420.1C Chg 3, DOE-STD-1020-2016; incorporated CIR-16-002 on seismically exempt anchors. Added 1.1.A to include guidance on mech & elec items outside IBC scope, added 1.4 for flood hazard; and edited 1.6 to reduce seismic hazard per updated PHSA (IM 2018-0495 CA 2) and add SDC C pathway; added A.12 to include requirement for $f'c$ for design of anchorage of nonstructural components to nonstructural concrete, A.13 to clarify adhesive-anchor drawing requirements, and A.14 content on CIP masonry anchorage. Issued reference on SDC C/D impacts. Many basis footnotes moved to requirements ID document.

Contact the Structural Standards POC

for upkeep, interpretation, and variance issues

Ch. 5, Section II	Structural POC/Committee
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- A. This Chapter is online at <http://engstandards.lanl.gov> This Section provides the minimum requirements for the structural design and analysis of new and existing commercial (i.e., non-nuclear¹) structures, systems, components (SSCs), to include non-building structures and, as applicable, programmatic equipment. Such designs/ analyses are performed using the International Building Code (IBC) and International Existing Building Code (IEBC), which are “commercial codes” (Requirement 5-0058).
- B. Acronyms, notations, references, etc. not defined herein are included in Subsections 2.0 – 4.0 of Section I of this Chapter.
- C. Per Section III of this Chapter, some nuclear SSCs (i.e., NDC-1 and NDC-2) require use of Section II. The initial portion of Section III includes the details of such.
- D. *Guidance: The structural design process generally consists of the following:*
- *Establish structural arrangement/ geometry*
 - *Establish loads and load combinations²*
 - *Establish a complete load path for vertical and horizontal loads*
 - *Evaluate the structural response to the loads*
 - *Specification of structural capacity and drift limits (acceptance criteria)*
 - *Application of special design considerations, such as ductile detailing requirements*
 - *Specification of inspections (e.g., special inspections) and tests*
- E. The project records, quality control, quality assurance, design and construction of non-nuclear SSCs shall comply with the provisions of Section I of this Chapter; ESM Chapter 1, General; ESM Chapter 16, IBC Program (which invokes a specific edition of the IBC and IEBC, and makes amendments to them); and the provisions contained

¹ Per DOE-STD-1020-2016, and as indicated in Section I, non-nuclear facilities are other than DOE Hazard Category 1, 2, and 3 nuclear facilities, and they can include radiological, chemical and/ or toxicological hazards. Refer to Section I (*Subsection 3.0*) for definitions of “nuclear facilities” and “non-nuclear facilities.”

² Unless noted/footnoted otherwise, “Design-Load Basis for LANL Structures, Systems, and Components,” LANL Report No. [LA-14165](#) [6] provides the basis for the non-seismic loads and analysis procedures.

herein (i.e., Section II), which include additional amendments to the IBC (i.e., Chapters 16–23) (Requirement 5-0059). The IBC and IEBC editions currently invoked are the 2015 ones.

- F. *Guidance: Note that Chapter 6 – Mechanical, Chapter 7 – Electrical, and others of this ESM also contain design requirements for many nonstructural components, and non-building structures.*

1.0 IBC CHAPTER 16 STRUCTURAL DESIGN

1.1 Section 1601.1 Scope

- A. ***Guidance on outside, on-the-ground equipment:*** *The IBC states it's applicable to "...buildings, structures and portions thereof..." Thus, mechanical and electrical items that aren't in/on buildings or structures—and aren't themselves nonbuilding structures—need not be designed for, or restrained to withstand, the effects of the natural phenomena hazards (NPH) included in this Section.³ However, if any of the following are applicable, NPH design for such items should be considered:*
- *Sliding, overturning and/or uplift of the item could damage an adjacent structure.*
 - *Sliding, overturning and/or uplift of the item could either impede egress of occupants from—or ingress of emergency responders to—a facility after an NPH event.*
 - *The item is difficult to acquire, costly, and/or critical and sliding, overturning and/or uplift of it could result in damage to and/or loss of use of it.*
 - *Resiliency of the item and/or facility or mission it serves is desired (i.e., less downtime than normal/typical after an NPH event).⁴*
- Finally, even if none of these NPH-design scenarios apply, it's recommended that such items be permanently attached to the foundation/ground, wherein the attachment isn't designed for seismic and wind loads and is sized using basic engineering judgement. Anchorage of such items using post-installed anchors doesn't require special inspection under the IBC Program.*

1.2 Section 1607 Live Loads

- A. **1607.9 Impact loads**
1. **Add 1607.9.5 Experimental explosion loads.**
 - a. Reactions from experimental explosion containment structures, due to explosions within them, shall be considered live loads that act concurrently with floor and roof live loads and that have a load factor of 1.0 for both strength design and allowable stress design (Requirement 5-0060).
 - b. External loads from experimental explosions shall comply with DOE-STD-1212 Section 7.2 and shall be considered live loads that act concurrently

³ The NPH included herein that are most likely to be applicable are seismic and wind. ASCE 7 Chapter 13, which is referenced by IBC paragraph 1613.1, includes seismic design requirements for mechanical and electrical (M&E) components that ARE in/on structures. ASCE 7 Ch. 15, also referenced in IBC 1613.1, includes seismic design requirements for M&E items that ARE themselves nonbuilding structures. And ASCE 7 Ch. 26, which is referenced in IBC para. 1609.1.1, includes wind design requirements for both M&E components that ARE on (top of) structures or ARE themselves nonbuilding structures.

⁴ The National Earthquake Hazards Reduction Program Reauthorization Act of 2018 (NEHRP18) goes beyond merely surviving a major earthquake, which is the goal of the IBC. With NEHRP18 preventing damage to structures and infrastructure and reducing economic hardship (following a major earthquake) will be emphasized.

with floor and roof live loads and that have a load factor of 1.0 for both strength design and allowable stress design (Requirement 5-0061).

1.3 Section 1608 Snow Loads

- A. **1608.2 Ground snow loads.** Substitute the following text:

The ground snow load shall be taken as 16 psf (Requirement 5-0062).⁵

1.4 Section 1609 Wind Loads

- A. **1609.1.1 Determination of Wind Loads.** Revise the second sentence to read as follows:

The ultimate design wind speed, V_{ult} , and the exposure category shall be as indicated in Section 1609 (Requirement 5-0063).⁶

- B. **1609.3 Ultimate design wind speed.** Substitute the following text:

The ultimate design wind speed, V_{ult} , for the determination of the wind loads for the design of buildings and structures shall be as follows (Requirement 5-0064):

- 105 mph for Risk Category I,
- 115 mph for Risk Category II, and
- 120 mph for Risk Category III and IV.

- C. **1609.4 Exposure category.** Substitute the following text:

The exposure category shall be taken as Exposure C for each wind direction considered (Requirement 5-0065).

1.5 Section 1612 Flood Loads

- A. Modify **1612.3 Establishment of flood hazard areas** to read as follows:

1612.3 Flood hazard areas. Pajarito Canyon, Los Alamos Canyon, and Water Canyon shall be considered *flood hazard areas*, the design flood elevations in which shall be determined in accordance with paragraph 1612.3.1 (Requirement 5-0066).

- B. Replace the first sentence in **1612.3.1 Design flood elevations** with the following one:

To determine the design flood elevations, the engineer of record is required to:

1. Obtain and reasonably utilize any...currently accepted engineering practice (Requirement 5-0067).

⁵ For roofs that will have three-dimensional snow drifts, consider referring to "FEMA Roof Snowdrift Design Guide," 2019, since it includes consideration of such based on assessments of actual roof collapses caused by them.

⁶ For photovoltaic (PV) wind design, references include this [article](#) and SEAOC report [PV2-2012](#).

1.6 Section 1613 Earthquake Loads

A. 1613.3 Seismic ground motion values

1. The following parameters shall be used for all Risk Categories unless the provisions and conditions in the exception at subparagraph 1.6.A.2 are met (Requirement 5-0068):

- a. **1613.3.1 Mapped acceleration parameters.** Substitute the following text:

S_s and S₁	
At short periods, S _s	0.92
At long periods, S ₁	0.73

- b. **1613.3.2 Site class definitions.** Substitute the following text:

The site class shall be taken as Site Class D except as demonstrated otherwise by site specific geotechnical information that Site Class C requirements are met.⁷

- c. **1613.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters.** Substitute the following text:

S_{MS} and S_{M1}	
At short periods, S _{MS}	0.82
At long periods, S _{M1}	0.67

- d. **1613.3.4 Design spectral response acceleration parameters.** Substitute the following text:

Five-percent damped design spectral response acceleration

At short periods, S _{DS}	0.55
At long periods, S _{D1}	0.44

- e. Replace in Sections 11.3 and 11.4.5 of ASCE 7, the definition for T_o from T_o = 0.2 S_{D1}/S_{DS} to T_o = 0.12 sec.
- f. **1613.3.5 Determination of seismic design category.** Substitute the following text:

The seismic design category shall be taken as Seismic Design Category D.⁸

2. Exception for Risk Category I and II structures. To use this exception, the conditions in subparagraph A.2.f below must be met; otherwise, the parameters outlined in subparagraph A.1 shall be used. This exception does not allow the

⁷ In order to meet Site Class C requirements, borings must be deeper than what has become the norm for LANL geotechnical investigations. Refer to IBC 1613.3.2 and ASCE 7 Ch. 20 for details. In the event that the geotechnical investigation indicates that Site Class E or F exist, para. 3.3.B (1809.13 Footing seismic ties) herein is applicable and shall be complied with.

⁸ In the event that the geotechnical investigation indicates that Site Class E or F exist, para. 3.3.B (1809.13 Footing seismic ties) herein is applicable and shall be complied with.

use of long-period accelerations. In addition, this exception isn't permitted for use with SDC-1 SSCs in nuclear facilities (Section III).

- a. **1613.3.1 Mapped acceleration parameters.** Substitute the following text:

At short periods, S _s	0.54
At long periods, S ₁	N/A

- b. **1613.3.2 Site class definitions.** Substitute the following text:

The site class shall be taken as Site Class D.

- c. **1613.3.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters.** Substitute the following text:

At short periods, S _{MS}	0.74
At long periods, S _{M1}	N/A

- d. **1613.3.4 Design spectral response acceleration parameters.** Substitute the following text:

Five-percent damped design spectral response acceleration

At short periods, S _{DS}	0.49
At long periods, S _{D1}	N/A

- e. **1613.3.5 Determination of seismic design category.** Substitute the following text:

The seismic design category shall be taken as Seismic Design Category C.^{9,10}

- f. **Conditions.** All of the following conditions must be met to use this exception:

- 1) Structure height from bottom of footings to the highest point of the seismic force resisting system is less than or equal to the following:¹¹

⁹ At time of writing, LANL Engineering Standards beyond this one (i.e., ESM Ch. 5) necessary for design and construction of a new structure using SDC C haven't been revised; EOR is authorized to edit as necessary. See newly-posted reference, *IBC SDC C vs. D – Effect on LANL Design* for details.

¹⁰ For modifications to existing buildings, refer to ESM Chapter 16 Section IBC-GEN Att B LANL Existing Building Code (LEBC) for design criteria. (*E.g., per LEBC, unless a variance is submitted and approved justifying doing otherwise, the use of SDC C for modifications to existing structures is limited to structures that were originally designed using SDC C.*)

¹¹ The intent of this exception is that natural frequencies of the structural systems and heights respond at natural frequencies such that the seismic analysis would be controlled by the S_{DS} parameter; thus, consideration of the S_{D1} parameter is not required.

Seismic Force Resisting System Type	Maximum Structure Height
Steel Moment Frame	25 feet
Concrete Moment Frame	33 feet
Steel Eccentrically/Buckling-Restrained Braced Frame	29 feet
All Other Systems ¹²	50 feet

- 2) Equation 12.8-2 of ASCE 7-10 is used to determine the seismic response coefficient.
 - 3) The diaphragms are rigid as defined in Section 12.3.1; or, for diaphragms that are not rigid (i.e., semirigid or flexible), the distance between vertical elements of the seismic force resisting system does not exceed 40 ft.¹³
- g. Guidance Note: For new facilities that will perform activities or operations that are not necessarily RC IV (essential) by IBC definition but considered important to the mission [e.g., mission-essential, mission-critical, or anticipated to have a high mission dependency index (MDI)], or where damage to the facility from a significant seismic event would cause adverse or unacceptable program interruption, utilization of the higher SDC-D categorization should be considered to ensure greater structure resilience and post-earthquake integrity—or selection of RC IV to ensure equipment also survives. LANL Project Engineer should engage customer on this matter and, if opting for SDC D or RC IV, capture this in RCD.¹⁴*

B. 1613.5 Amendments to ASCE 7

1. Add **1613.5.2 Siting**. Modify ASCE 7 **11.8.1, Site Limitation for Seismic Design Categories E and F**, to read as follows:

Site Limitation

Hazardous waste treatment, storage and disposal facilities must not be located within 200 feet of a fault that has had displacement within the last 11,000 years (Requirement 5-0069).

2. Add **1613.5.3 Design Approach to Commercially Fabricated Buildings Used in Multi-State Jurisdictions**. Refer to Appendix B of this document.

¹² Prior approval from ESM Structural POC is required in order to use an "All Other System." The reason being, the intent of the applicable code provisions (i.e., IBC 1613.3.5.1 and ASCE 7 12.8.2.1 and 12.8.6.2) is that they are applied to a specific SFRS, and CAL-99-MULT-651 (i.e., the source of the seismic ground motions values herein, to include the "SDC-C exception") does not apply to any specific SFRS. Thus, it is more than reasonable/prudent for LANL to ensure that a given "All Other System" intended to be installed here (and under the exception) complies with the applicable code provisions. SDC D shall be used if prior approval is not obtained, or if the SFRS of the "All Other System" is not approved (for use with SDC C).

¹³ The 40-foot-spacing limitation shall be assumed to be applicable unless it is demonstrated that the rigid-diaphragm condition exists (in accordance with ASCE 7-10 Section 12.3.1).

¹⁴ MDI is a 1-100 score calculated for each facility to measure its impact to the mission by combining the consequences if the facility was lost, the difficulty to replace it, and the interdependency of it to other facilities. MDI also links assets to the core capabilities they support which provides greater insight for understanding risks. (NNSA Office of Safety, Instructure, and Operations Real Property Asset Guide, dated May 2020). LANL's Infrastructure Program Office ([IFPROG](#)) can provide the MDI score for existing LANL Facilities and probable score of proposed ones.

3. Add **1613.5.4 Nonstructural Components Exempt from Seismic Design**. Modify ASCE 7 **13.1.4, Exemptions**, to read as follows (Requirement 5-0070):
Exemptions. The following nonstructural components are exempt from the requirements of this chapter.
 - a. Furniture (except for “Cabinets” in ASCE 7 Table 13.5-1)¹⁵.
 - b. Temporary¹⁶ or movable components/equipment¹⁷.
 - c. As stated in subparagraphs 5 and 6 of ASCE 7 paragraph 13.1.4.
4. Add **1613.5.5 Anchorage of architectural, mechanical, and electrical components**. Refer to Appendix A, *Anchorage to Concrete and Masonry*, of this document.
5. Add **1613.5.6 Restraint of Non-Facility Equipment (e.g., Programmatic, Utilities, Infrastructure, Environmental Remediation, etc.)**. Refer to Appendix C, *Restraint of Non-Facility Equipment*, of this document.

1.7 Add Section 1616 Accidental Blast Loads

- A. Permanent explosive facilities shall comply with DOE-STD-1212 Section 7.1 (Requirement 5-0071). When evaluating for accidental blast load, A_B , A_B shall replace E (earthquake load) in the load combination equations (Requirement 5-0072). All potential blast effects shall be considered including blast overpressure, gas pressure, fragments, and ground shock (Requirement 5-0073).
- B. The design of all new facilities containing explosives, or those that can be affected by detonation (inadvertent or planned) of explosives, shall comply with DOE-STD-1212 Section 7.5¹⁸ (Requirement 5-0074).
 1. This requirement also applies to significant (e.g., IEBC Alteration Level 3) modifications of facilities containing explosives, or of facilities that can be affected by detonation (inadvertent or planned) of explosives (Requirement 5-0075).

1.8 Add Section 1617 Minimum Antiterrorism Structural Design Measures

Structural design measures on progressive-collapse avoidance and window protection presented in DOD UFC 4-010-01 shall be considered for those buildings where there is a credible terrorist threat (Requirement 5-0076). LANL Physical Security (PS) Division shall specify (to the LANL Project Manager) whether these minimum antiterrorism measures are to be implemented; see also ESM Chapter 9, *Facility Protection and Security* (Requirement 5-0077).

¹⁵ No cabinet-like furniture is exempt (e.g., relatively tall, narrow, and heavy components /equipment, like some safes, etc.).

¹⁶ Refer to ESM Ch. 16, IBC-GEN [*Article, TEMPORARY FACILITIES, STRUCTURES, AND BUILDING SYSTEMS & COMPONENTS (Z1050)*]

¹⁷ Movable components /equipment that are not “temporary”, are not moved often, are in/ near occupied areas, and that are cabinet-like will likely require at least “non-permanent anchorage (e.g., detachable cable restraint, etc.)”. Contact the ESM Ch. 5 POC for guidance.

¹⁸ Per DOE-STD-1020 para. 2.2.5, it is permissible to use DOE-STD-1212 in order to satisfy the provisions of 10 CFR Part 851. This portion of “1020” also refers to 29 CFR Part 1910.109.

2.0 IBC CHAPTER 17 SPECIAL INSPECTIONS AND TESTS

Refer to LANL ESM Chapter 16, IBC Program for LANL amendments to this and other IBC chapters.

3.0 IBC CHAPTER 18 SOILS AND FOUNDATIONS

3.1 Section 1803 Geotechnical Investigations

A. 1803.5 Investigated Conditions.

1. **1803.5.12 Seismic Design Categories D through F.** Modify the first item (i.e., "1.") to read as follows (Requirement 5-0078):

The determination of dynamic seismic lateral earth pressures...A conservative alternative for obtaining such pressures on exterior embedded walls is use of the Simplified Method in ASCE 4 (para. 8.2.2). And, for retaining walls, such pressures can be obtained using the Mononobe-Okabe approach in accordance with ASCE 4 (para. 8.3).

3.2 Section 1808 Foundations

A. 1808.1 General. Add the following text (Requirement 5-0079):

Permanent buildings and similar structures shall have a permanent foundation (e.g., full perimeter support, rodent-excluding, no trailer skirting, etc.). Permanent is described in ESM Chapter 16, Section IBC-GEN.

1. Exception: For non-temporary relocatable buildings (as defined in ESM Chapter 16, Section IBC-GEN), a permanent foundation may be achieved by placing gravity bearing pads on 24 inches of non-frost susceptible ground or fill (95% compacted granular material with less than 6% material passing the 200 sieve)*, and providing insulated skirting around the perimeter of the building, and by providing a means to resist the lateral and uplift forces that result from seismic and wind loads. *For temporary foundations for temporary relocatable buildings, see LANL Standard Detail ST-Z1052-1 and -2.*

* If fill is used, it must replace the existing material to depth of at least 24 inches.

3.3 Section 1809 Shallow Foundations

A. 1809.5 Frost protection. Edit the first sub-bullet (i.e., "1") to read as follows: Extending to 36" (Requirement 5-0080).

B. 1809.13 Footing seismic ties. Revise the first sentence to read as follows (Requirement 5-0081):

Individual spread footings founded on soil defined in Section 1613.3.2 as Site Class E or F shall be interconnected by ties.

4.0 IBC CHAPTER 19 CONCRETE

4.1 Section 1901 General

- A. **1901.3, Anchoring to concrete** Revise the first part of the sentence to read as follows, and add the following second sentence (i.e., an exception) (Requirement 5-0082):

Anchoring to concrete shall be in accordance with Appendix A, *Anchorage to Concrete and Masonry* of this document; ACI 318 Chapter 17; and the amendments to ACI 318 Chapter 17 in Section 1905.

Exception: *Seismic-related provisions are not applicable to anchoring that is seismically-exempt per Appendix A.*

4.2 Section 1904 Durability Requirements

Add **1904.3 Mass Concrete** (Requirement 5-0083):

- A. Mass concrete is defined as "any volume of structural concrete in which a combination of dimensions of the member being cast, the boundary conditions, the characteristics of the concrete mixture, and the ambient conditions can lead to undesirable thermal stresses, cracking, deleterious chemical reactions, or reduction in the long-term strength as a result of elevated concrete temperature due to heat from hydration. *In general, a placement of structural concrete with a minimum dimension ≥ 4 ft should be considered mass concrete. Similar considerations should be given to other concrete placement that do not meet this minimum dimension but contain Type III cement, accelerating admixtures, or cementitious materials in excess of 660 lb/yd³ of concrete. Consideration should also be given to placements that trap heat.*
- B. The Construction Documents shall designate those portions of the structure, or concrete placement that are to be treated as mass concrete. The Project Specification (e.g., Section 03 3001, *Reinforced Concrete*) shall adopt the ACI 301, Section 8 requirements. The structural Engineer of Record (SEOR) shall review the Project-Specification-version of 03 3001 against the checklists presented in ACI 301 (i.e., Mandatory, Optional Requirements, and Submittals) to ensure that this Section adequately addresses mass concrete.
1. In lieu of mass concrete designation and specification requirements, the SEOR can opt to demonstrate (analytically, using ACI 207.2R) that these requirements are not required/applicable.

5.0 IBC CHAPTER 20 ALUMINUM

No change.

6.0 IBC CHAPTER 21 MASONRY

6.1 SECTION 2107 ALLOWABLE STRESS DESIGN

- A. **2107.1 General.** Add the following sentence to the end (Requirement 5-0084):

Anchoring to masonry shall be in accordance with Appendix A, *Anchorage to Concrete and Masonry* of this document and TMS 402/ACI 530/ASCE 5.

6.2 SECTION 2108 STRENGTH DESIGN OF MASONRY

- A. **2108.1 General.** Add the following sentence to the end (Requirement 5-0085):

Anchoring to masonry shall be in accordance with Appendix A, *Anchorage to Concrete and Masonry* of this document and TMS 402/ACI 530/ASCE 5.

7.0 IBC CHAPTER 22 STEEL

7.1 SECTION 2205 STRUCTURAL STEEL

- A. **2205.1 General:** Add the following text (Requirement 5-0086):

Designs shall allow for, if not ensure, compliance with OSHA provisions 29 CFR 1926, Subpart R (Steel Erection), Section 755(a), General Requirements for Erection Stability. Columns shall be securely anchored with a minimum of four (4) anchor rods or anchor bolts to address construction safety. Furthermore, each column base plate assembly, including the column-to-base plate weld and the column foundation, shall be designed to resist a minimum eccentric gravity load of 300 pounds located 18 inches from the extreme outer face of the column in each direction at the top of the column shaft to address construction safety. *See also LANL Master Specification Section [05 1000](#), Structural Metal Framing, for additional discussion.*

8.0 IBC CHAPTER 23 WOOD

No change.

9.0 IBC CHAPTER 31 SPECIAL CONSTRUCTION

9.1 SECTION 3108 TELECOMMUNICATION AND BROADCAST TOWERS

- A. **Guidance on 3108.1 General:** *The IBC states, "...Towers shall be designed for seismic loads; exceptions related to seismic design listed in Section 2.7.3 of TIA-222 shall not apply."*¹⁹

¹⁹ Recent LANL experience indicates that this industry isn't aware of this provision.

10.0 RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	6/28/99	Initial issue in Facility Eng Manual.	Doug Volkman, <i>PM-2</i>	Dennis McLain, <i>FWO-FE</i>
1	2/09/04	Incorporated IBC & ASCE 7 in place of UBC 97; incorporated DOE-STD-1020-2002 versus 1994 and concepts from DOE O 420.1A; FEM became ESM, an OST.	Mike Salmon, <i>FWO-DECS</i>	Gurinder Grewal, <i>FWO-DO</i>
2	5/17/06	Major revision: Reduced commentary in favor of IBC 2003 amendments only; clarification of PC-0 applicability; OST became ISD.	Mike Salmon, <i>D-5</i>	Mitch Harris, <i>ENG-DO</i>
3	10/27/06	Administrative changes only. Organization and contract reference updates from LANS transition; 420.1A became 420.1B. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates.	Mike Salmon, <i>D-5</i>	Kirk Christensen, <i>CENG</i>
4	6/19/07	Incorporated new seismic hazard analysis results into the seismic design parameters (1.7.1); supersedes Salmon interim guidance of 1/22/07 (D5:07-021). Added App A on concrete anchor design.	Mike Salmon, <i>D-5</i>	Kirk Christensen, <i>CENG</i>
5	6/16/08	Incorporated IBC 2006 & ASCE 7-05 in place of IBC 2003 & ASCE 7-02; minor App A changes.	Mike Salmon, <i>D-5</i>	Kirk Christensen, <i>CENG</i>
6	6/20/11	Update for IBC 2009. New Commentary on design and inspection. Admin changes including document number.	Mike Salmon, <i>D-5</i>	Larry Goen, <i>CENG</i>
7	10/30/12	Added TA-50/55 ground motion values at 1613.5, mass concrete at 1904, erection planning at 2205.1, drawing requirements in App A. Updated references.	Mike Salmon, <i>AET-2</i>	Larry Goen, <i>ES-DO</i>
8	11/03/14	Consolidated anchorage App. A, added adhesive anchors and limited use of anchorage to masonry; also, eliminated former brittle PI anchor procedure in deference to similar provision in IBC 2009/ ACI 318-08. Other minor changes in section proper.	Mike Salmon, <i>AET-2</i>	Mel Burnett, <i>ES-DO</i>
9	3/27/15	Major revision. Incorporated IBC-2015, DOE-STD-1020-2012 versus 2002, and anchorage material from Sect I App A. Eliminated historical 10-psf future-floor-DL and, for roofs, 30-psf min roof LL (Lr) and prohibition on LL reduction. Eliminated Commentary companion to this document.	Mike Salmon, <i>AET-2</i>	Larry Goen, <i>ES-DO</i>
10	12/20/16	Programmatic anchorage flowchart superseded by Ch 16. Other changes to App A, mostly A.13 anchorage drawing requirements. Added App B on small offsite-built structures.	Mike Salmon, <i>AET-2</i>	Larry Goen, <i>ES-DO</i>

11	03/24/21	<p>Adopted DOE O 420.1C Chg 3, DOE-STD-1020-2016; incorporated CIR-16-002 on seismically exempt anchors. Added 1.1.A to include guidance on mech & elec items outside IBC scope, added 1.4 for flood hazard; and edited 1.6 to reduce seismic hazard per updated PHSA (IM 2018-0495 CA 2) and add SDC C pathway; added A.12 to include requirement for f'_c for design of anchorage of nonstructural components to nonstructural concrete, A.13 to clarify adhesive-anchor drawing requirements, and A.14 content on CIP masonry anchorage. Issued reference on SDC C/D impacts. Many basis footnotes moved to requirements ID document.</p>	<p>Glen Pappas, <i>ES-EPD</i></p>	<p>Jim Streit, <i>ES-DO</i></p>
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APPENDIX A – ANCHORAGE TO CONCRETE AND MASONRY

A.1 Description

- A. This appendix establishes the technical design requirements for designing concrete anchors for non-nuclear SSCs at LANL. There are different design criteria for anchorage of nuclear SSCs. An anchor type /product acceptable for a nuclear SSC may be used for a non-nuclear SSC.
- B. Not included: Design of anchorage for nuclear SSCs except nuclear facility SSCs that are designated NDC-1 or NDC-2 must also follow this appendix (as indicated by, and per modifications in, Section III) (Requirement 5-0087).
- C. Cast-in-place (CIP) anchors: This appendix covers the design of the following CIP anchors: Headed bolts, threaded and nutted bolts, headed studs, and hooked bolts. Cast-in anchors are ASTM A36, A193, A354 Gr. BD, A449, A572, A588, or F1554 material. ASTM F1554 Gr. 55 is the preferred material specification in AISC 360. Welding and mechanical properties of headed studs shall comply with AWS D1.1 (per AISC 360) and ESM Chapter 13–*Welding, Joining, and NDE* (Requirement 5-0088).
- D. Post-installed (PI) anchors: This appendix covers the design of the following types of PI concrete anchors: expansion, adhesive, undercut, screw, and power-actuated. PI anchorage to grout-filled concrete masonry (“grouted-masonry anchors” hereafter) is also covered, as is grouted rebar. Purchase, installation, and testing requirements for PI anchors are given in the LANL Master Specification Sections listed below
- E. Definitions: Definitions of anchors per ACI 355.2 and ACI 355.4 apply (Requirement 5-0089).

A.2 Applicable Codes

IBC International Building Code by International Code Council (ICC), edition per ESM Ch. 16 (Requirement 5-0090).

A.3 Applicable Industry Standards and Reports (Requirement 5-0091)

ACI 355.2	Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary
ACI 318	Building Code Requirements for Structural Concrete and Commentary
ICC-ES ACs	ICC Evaluation Service Acceptance Criteria (http://www.icc-es.org/) (reference only; bases for ES Reports) <ul style="list-style-type: none"> • AC01, “Expansion Anchors in Masonry Elements,” August 2013 • AC58, “Adhesive Anchors in Masonry Elements,” August 2013. • AC106, “Predrilled Fasteners (Screw Anchors) in Masonry,” May 2012
ICC ES Reports	ICC Evaluation Services Reports (http://www.icc-es.org/)

A.4 LANL Documents

Master Specification STD-342-200 (Requirement 5-0092)

Section 03 6000	Grouting
Section 05 0520	Post-installed Concrete and Grouted-Masonry Anchors – Normal Confidence
Section 05 0521	Post-installed Concrete Anchors – High Confidence

Engineering Standards Manual (Requirement 5-0093)

Chapter 13	Welding, Joining, and NDE
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Appendix A, Anchorage to Concrete and Masonry

Chapter 16

IBC Program, Section IBC-GEN

LANL Standard Details for anchorage

Note: At time of writing, these details include anchorages complying with IBC-2015 expectations.

- Sign Base Detail and Alternate, ST-G2040-4
- Motor Control Center Anchorage, ST-D5020-3
- Wall-Mounted Enclosures (I&C), ST-F1033
- Three-Phase Transformer Concrete Pads and Anchorage Requirements, ST-G4010-38

A.5 Prerequisites for Determining Anchor Design Loads

- A. As indicated in IBC/ASCE 7, the magnitude of natural-phenomena-hazard (NPH) loading that a structure (and a non-building structure, and structural /nonstructural anchorage) must be designed to resist depends on its Risk Category (RC). If the RC of a building/structure has not already been assigned (in accordance with IBC 1604.5), then this must be accomplished by the Project design team (Requirement 5-0094). *This team will likely consist of at least some of the following: LANL Project Management, a safety analyst, the SEOR, and the Cognizant System Engineer (responsible for the design of mechanical and electrical equipment).*
- B. *Unlike the design of the anchorage of structures (ref. A.5.A), the design of the anchorage of many (nonstructural) systems and components is NOT directly tied to RC. The only type of NPH that many systems and components must be braced and/or anchored to resist is seismic; and in order to determine the seismic-design load (i.e., F_p), ASCE 7 (in its Chapter 13) requires the use of a Component Importance Factor, I_p . The value of I_p can be 1.0 or 1.5, depending on the importance of the system/ component. ASCE 7 lists the conditions that require the use of $I_p = 1.5$, and only one of them is related to RC. Thus, additional time and effort will be required by the team (refer to A.5.A) in order to provide the necessary input for the design of system/component anchorage.*
- C. *The value of I_p for a given system or component (ref. A.5.B) may not be sufficient to determine F_p , (and, subsequently, design the anchorage). The reason being Consequential Damage (ref. ASCE 7, paragraph 13.2.3) / System Interaction (ref. DOE - STD-1020-2016, paragraph 2.3.2(b)). Consideration of consequential damage requires the team (ref. A.5.A) to assess the potential for functional and physical interactions between essential/ safety systems and components and nonessential/ non-safety systems and components. If the potential exists for such interactions, the team must then determine whether or not they are both credible and significant. In short, the failure of essential or nonessential systems and components shall not cause the failure of essential ones, and ensuring such can affect anchorage design (Requirement 5-0095). For example, if there is a suspended ' $I_p = 1.0$ ' piping system directly above an ' $I_p = 1.5$ ' motor control center (MCC), increasing the I_p used to design the anchorage of the piping system (to 1.5) might be necessary. And similar would apply to an ' $I_p = 1.0$ ' piping system located above an NDC-3 / safety-class MCC, etc.²⁰ If the affected essential SSC is SDC-3 then Section III on System Interaction (para 1.7.2) must be met.*
- D. Engineering drawings shall indicate the designated RC, I_p , and I_e values used to design the anchorage of SSCs (Requirement 5-0096).

²⁰ For more information and examples, see ASCE 7-013 para. C13.2.3 and DOE-STD-1020-2016, para. 2.3.2.

Appendix A, Anchorage to Concrete and Masonry

A.6 Environmental Conditions

- A. Anchors for indoor use in non-aggressive chemical environments may be carbon steel with zinc electroplating. Anchors for use outdoors or in aggressive environments shall be galvanized or made of stainless steel (Requirement 5-0097).

A.7 Seismically Exempt Anchors²¹

- A. Anchors for nonstructural components that are exempt per paragraph 1.6.B.3 of this document need not be designed for seismic forces.
- B. Seismically exempt anchors must comply with the provisions of this Appendix other than those related to the design for seismic forces, and the prohibition herein against the use of PI anchors in masonry (*under General Design Requirements*) doesn't apply to seismically-exempt anchors in masonry (Requirement 5-0098).

A.8 Power-Actuated Fasteners

- A. Power-actuated fasteners may be used for anchorage of nonstructural components provided that such use is in accordance with ASCE 7, paragraph 13.4.5 (Requirement 5-0099). "Approved" in paragraph 13.4.5 shall be taken to mean allowed by the IBC and applicable ICC ES report (ESR) (Requirement 5-0100). Finally, design shall comply with all requirements of the respective ESR (e.g., minimum spacing, edge distance, embedment; maximum loads; etc.) (Requirement 5-0101).

A.9 Grouted Reinforcing steel

- A. Reinforcing steel (rebar) may be post-installed into hardened concrete by using an epoxy or acrylic grout (i.e., adhesive anchor per ACI 318 Chapter 17, or post-installed reinforcing bar per ICC-ES AC 308). The design of epoxy and acrylic grouted rebar shall be in accordance with the applicable ICC-ES ESR, or equivalent (Requirement 5-0102).
- B. Rebar may be post-installed into hardened concrete by using a cementitious grout. The design of cementitious grouted rebar shall be in accordance with a procedure that must be reviewed and approved by the ESM Structural POC prior to use (Requirement 5-0103). *Use of ACI 349 Section D.12, Grouted embedments, is pre-approved; thus, need not be submitted for review to ESM Structural POC prior to use.*

A.10 Requirements for Transfer of Shear Load to Foundations

- A. For structures where the eave height exceeds twenty feet, in order to rely on all anchor rods equally sharing in the transmission of shear loads from steel columns of the lateral force-resisting system to concrete foundation elements, in addition to complying with the applicable provisions in AISC 360 Section J9, Anchor Rods and Embedments; AISC 341 Paragraph D2.6, Column Bases; and ACI 318 Chapter 17, Anchoring to Concrete, both of the following items are required (Requirement 5-0104):
 - 1. Plate washers of proper thickness, and with holes 1/16 inch larger than the rod diameter, must be welded to the base plate at all anchor locations.
 - a. In lieu of plate washers, a setting plate of proper thickness can be used and welded to the base plate after the column is erected.

²¹ The term "non-structural anchors" was used in this document prior to the Rev. 9 (Mar 2015) edition.

Appendix A, Anchorage to Concrete and Masonry

2. The thickness of the washers/setting plate shall be based on the bearing force from the rod, and the rod diameter shall be adequate to resist the effects of bending/flexure (i.e., in addition to the effects of tension, and combined tension and shear).

A.11 General Design Requirements

- A. *CIP anchors (ref. Description herein) should be used in lieu of PI anchors whenever possible.*
- B. Use of PI anchors shall comply with the following:
 1. PI anchor design shall provide for limited anchor relocation (at least ± 1 inch) to facilitate anchor installation (Requirement 5-0105). Due consideration shall be given to the location tolerances of the anchors to avoid interferences with reinforcement.
 2. Welding of PI anchors, to include welding base plates to them, is not permitted without the permission of the anchor manufacturer (Requirement 5-0106). And such permission must be submitted to the SEOR (for review and approval) prior to commencement of welding (Requirement 5-0107).
 3. Except as indicated below (in Design Requirements below), PI anchors shall not be used in masonry walls (Requirement 5-0108). Through-bolting may be an acceptable alternative.
 4. PI anchors shall not be located in the bottom of precast and pre/post-tensioned T-beam stems (Requirement 5-0109). PI anchors in the sides of the T-beam stems shall be designed, and the design must be approved by the SEOR (Requirement 5-0110).
 5. Adhesive anchors shall not be used in environments with temperature extremes in excess of that allowed by the applicable ESR (Requirement 5-0111). Manufacturer's data and ESRs typically require a reduction in strength at elevated temperatures, and stipulate limitations on use in aggressive exposure conditions including fire. *At elevated temperatures where strength reduction is significant for epoxy and adhesive anchors, consider the use of cementitious grout.*

A.12 Design Requirements

- A. Anchor types/ products must comply with the IBC as amended below.
- B. Additional requirements for architectural, mechanical, and electrical components, and their supports and attachments. (ref. 1613.5 Amendments to ASCE 7 in Section II).
 1. Revise ASCE 7, Section 13.4.2 as follows:

13.4.2 Anchors in Concrete or Masonry

13.4.2.1 Anchors in Concrete. Replace the one and only sentence with the following (Requirement 5-0112):

Anchors in concrete used for component anchorage shall be designed in accordance with LANL ESM Chapter 5 Section II.

Appendix A, Anchorage to Concrete and Masonry

13.4.2.2 Anchors in Masonry. Replace the first sentence with the following (Requirement 5-0113):

Anchors in masonry shall be designed in accordance with LANL ESM Chapter 5 Section II.

13.4.2.3 Post-Installed Anchors in Concrete and Masonry. Replace the second sentence with the following (Requirement 5-0114):

PI anchors in masonry used for component anchorage shall be prequalified for seismic applications in accordance with ICC-ES AC01, AC58, or AC106.

- C. **Sections 2107.1 and 2108.1 General.** Add the following text at the end of 2107.1 and 2108.1 (Requirement 5-0115):

PI anchors can be used in masonry provided they comply with all applicable provisions in the "General Design Requirements" article above.

- D. Anchorage of nonstructural components to nonstructural concrete shall be based on a value of f'_c that doesn't exceed 2,500 psi (Requirement 5-0116).

1. Exception 1: The design of anchorage to existing concrete can be based on a value of $f'_c > 2,500$ psi if that's the only way the design will work and if documentation that proves/ verifies the value of f'_c used in the design is appended to the design calc and submitted for review.
2. Exception 2: The design of anchorage to new concrete can be based on a value of $f'_c > 2,500$ psi if that's the only way the design will work and if strength-test cylinders, and Special Inspection of the associated preparation and test results, are indicated as being required.

A.13 Drawing Requirements

- A. For non-seismically-exempt anchors the SEOR shall specify each anchor to be installed as follows: type, size, location requirements, effective embedment depth, minimum edge distance (in accordance with ACI 318 paragraph 17.7), and installation requirements in ACI 318 paragraph 17.8 (Requirement 5-0117).²²
- B. In addition to the above, for PI anchors, the SEOR shall indicate the manufacturer's name, product name, anchor diameter, minimum spacing, and the ESR number (Requirement 5-0118). Also, in instances in which the product has options for the type and grade of the steel, the steel type and grade to be installed must be specified (Requirement 5-0119). Finally, for adhesive anchors, in addition to the drawing requirements indicated in Specification Section 05 0520, the following shall also be indicated (Requirement 5-0120):
1. Anchors that are horizontal or upwardly inclined that support sustained tension.
 2. Service environment of anchors (i.e., "Indoor" or "Outdoor" per ACI 318 17.4.5.2).
 3. Concrete temperature range at installation (i.e., minimum and maximum temperatures in °F).

²² Per the author note for Para. 1.3.F of LANL Master Spec Section 05 0520, seismically-exempt anchors must be identified; however, such identification need not include all of the specificity required for non-seismically-exempt anchors.

Appendix A, Anchorage to Concrete and Masonry

4. Moisture condition of concrete at installation (i.e., dry, saturated, water-filled hole, or submerged hole).
- C. The SEOR shall specify, for each location in which a PI anchor is to be installed, parameters associated with the strength used for design, including anchor category and "base-material-specific information" listed below (Requirement 5-0121). In the event that none of these parameters/properties change from one anchorage location to another, they need only be indicated once.
1. Concrete Installations: Concrete type (i.e., normal- versus light-weight); compressive strength, f'_c ; and thickness.
 2. Grouted-Masonry Installations: Masonry compressive strength (f'_m) and thickness; concrete masonry unit (CMU) type (i.e., grade; type; and weight); mortar type (i.e., M, S, or N); and grout compressive strength, f'_g .
- NOTE: There are differences in CMU and mortar types permitted by the ESRs for masonry anchors acceptable for use (per A.12.B).
- D. The SEOR shall indicate which, if any, anchors to be installed are Seismically Exempt Anchors (per A.7 herein) (Requirement 5-0122).
- E. The SEOR shall indicate corrosion protection for exposed anchors intended for attachment with future Work (Requirement 5-0123).

A.14 Recommended Methodology for Seismic Design of Anchorage to Concrete or Masonry for Nonstructural Components

- A. Determine demand on component.
2015 IBC (1613) → ASCE 7-10 (Chapter 13, 13.2.3, 13.3 and 13.4)
- B. Compute demand(s) on anchorage, to include any prying effects and allowance for (potential) ± 1 inch anchor relocation.
1. For concrete, ACI 318-14 (Chapter 17, 17.2) will affect the demand(s) that must be designed for in many instances.
 2. For grouted masonry, Allowable Stress Design (ASD) is a permissible alternative to Strength Design (SD; also known as Load and Resistance Factor Design, or LRFD).²³
- C. Compute anchor capacities, to include allowance for (potential) ± 1 inch anchor relocation.
1. For concrete, compute anchor capacities for various failure modes per ACI 318-14 (Chapter 17, 17.2 – 17.3).
 2. For grouted masonry, use TMS 402-13/ACI 530-13/ASCE 5-13 (Chapter 8, 8.1.3.3 for ASD; or Chapter 9, 9.1.6.3 for SD) for CIP anchors; and, for PI anchors, use ICC-ES reports based on ICC-ES AC01, AC58, or AC106.
- D. Determine capacity of anchorage.
1. For concrete, compute the anchor strengths indicated in ACI 318-14 (Chapter 17, 17.3.1).

²³ If ASD is selected, the seismic demand, F_p (ref. ASCE 7, 13.3) can be reduced by 30% (i.e., multiplying by 0.7). This reduction is required by ASCE 7, 13.1.7 for some ASD designs. Regardless of whether ASD or SD is selected, the demand for a CIP anchor(s) may have to be increased per ASCE 7 para. 13.4.2.2.

Appendix A, Anchorage to Concrete and Masonry

2. For grouted masonry, compute the anchor strengths using TMS 402-13/ACI 530-13/ASCE 5-13 (Chapter 8, 8.1.3.3 for ASD; or Chapter 9, 9.1.6.3 for SD) for CIP anchors²⁴; and, for PI anchors, using ICC-ES reports based on ICC-ES AC01, AC58, or AC106.
- E. Check capacity \geq demand, to include, if applicable, interaction.
1. For concrete, ensure compliance with ACI 318-14 Ch. 17, 17.3.1.1 and 17.6. Regarding the latter, the provisions of 17.6 or the equation in R17.6 may be used.
 2. For grouted-masonry, ensure compliance with TMS 402-13/ACI 530-13/ASCE 5-13 (Chapter 8, 8.1.2 and 8.1.3.3.3 for ASD; or Chapter 9, 9.1.3 and 9.1.6.3.3 for SD) for CIP anchors; and with ICC-ES reports based on ICC-ES AC01, AC58, or AC106 for PI anchors.

²⁴ Per ASCE 7 para. 13.4.2.2 a ductile steel element shall govern capacity, or else either ductile yielding of the support prior to anchor capacity being reached shall govern capacity, or the demand shall be increased by 2.5.

Appendix B, Design Approach to Commercially Fabricated Buildings used in Multi-State Jurisdictions

APPENDIX B – DESIGN APPROACH TO COMMERCIALLY FABRICATED BUILDINGS USED IN MULTI-STATE JURISDICTIONS²⁵

1. Approval is currently limited to the following (others with Chapter POC written permission): ARMAG, MSSI, and US Chemical.
2. For ASCE 7 Risk Category I, II, and III (Table 1.5-1) structures and designated-as-ML-4 structures that are not included as credited SSCs in nuclear or radiological safety documentation, commercially fabricated building-like structures that are not one of the type categories described in ASCE 7 Chapter 12 may be designed/treated as follows:
 - a. Such buildings may be treated as those structures that are designed and detailed in accordance with ASCE 7 Section 15.5 for non-building structures similar to buildings, as stipulated in Section 11.1.3. However, if a nationally marketed structure type does not fit into the categories listed in Chapter 12 or in Section 15.5, then ASCE 7 Section 15.6 covering non-building structures not similar to buildings shall be used as the default structure type under the listing of "All other self-supporting structures, tanks, or vessels not covered above or by reference standards that are not similar to buildings."

²⁵ A commercial building that is marketed nationally is termed "commercial building structure." Typically, these structures are factory built, transported to the site on trailers, and anchored to engineered foundations. At LANL, the intended purpose for these structures is to serve as storage facilities, control facilities for experimental work, weather proofing structures for materials, equipment or piping systems, security portals for entry access, etc. These structures are sometimes occupied, but not continuously; the occupancy is limited for the special purpose of the facility. These structures have building geometries and framing systems that may be different from the broader class of occupied structures addressed in ASCE 7, Chapter 12.

ASCE 7-10, 11.1.3, states:

"Structures and their nonstructural components shall be designed and constructed in accordance with the requirement of the following sections based on the type of structure or component:

- a. Buildings: Chapter 12
- b. Nonbuilding Structures: Chapter 15
- c. Nonstructural Components: Chapter 13
- d. Seismically Isolated Structures: Chapter 17
- e. Structures with Damping Systems: Chapter 18

Buildings whose purpose is to enclose equipment or machinery and whose occupants are engaged in maintenance or monitoring of that equipment, machinery or their associated processes shall be permitted to be classified as nonbuilding structures designed and detailed in accordance with Section 15.5 of this standard..."

The limited nature of the occupancy associated with these structures reduces the life-safety risk associated with their performance in hazards such as wind and earthquakes, and therefore appropriately applies to these classes of structures as implied in the text of Section 11.1.3. This approach to Section 11.1.3, to cover both Section 15.5 and the default structure reference of Section 15.6, is necessary to cover structures in which hybrid structural systems, such as when structural steel and cold formed members are used concurrently, or other non-listed structural types that are commonly fabricated and marketed nationally.

These structures are comparatively small with respect to normal building structures and have inherent strength that is not always accounted for in normal engineering calculations. Also, given that they are transported to the site on trailers, they are essentially load-tested while in transport through road vibration and wind resistance. This provides added assurance of acceptable performance.

This approach is in keeping with ASCE 7-10, Section 11.1.4 Alternate Materials and Methods of Construction, which states "alternate materials and methods of construction to those prescribed in the seismic requirements of this standard shall not be used unless approved by the authority having jurisdiction. Substantiating evidence [as described in this clarification] shall be submitted demonstrating that the proposed alternate will be at least equal in strength, durability, and seismic resistance for the purpose intended." Approval relies on the fact that commercial building structures are engineered and that all such structures have design documents that have been appropriately stamped by a registered professional engineer. See [ESM Ch 16](#) IBC-GEN on Prefab. This appendix incorporates and supersedes Clarification CIR-16-004.

APPENDIX C – RESTRAINT OF NON-FACILITY (E.G., PROGRAMMATIC) EQUIPMENT

Note: This appendix supersedes similar material where it exists in ESM Ch. 16.

Restraint (i.e., anchorage and/or bracing) of non-facility (e.g., programmatic, utility, infrastructure, environmental remediation) equipment is required in either of the following circumstances (Requirement 5-0124):

1. When required by the **manufacturer** for normal operations.²⁶
 - a. If this is the sole reason restraint is required (i.e., seismic restraint per criterion 2 below not required), then the design need not be per ESM Ch. 5 if the manufacturer provides alternative design requirements (Requirement 5-0125).
2. **In a non-nuclear facility**, seismic restraint is required unless the equipment is "Seismically Exempt" per Section II paragraph 1.6.B.3 (Requirement 5-0126).
 - a. If seismic restraint is required, the design must comply with Ch.5 Section II, the installation and quality control per the appropriate LANL Master Spec(s), and the QA per ESM Ch. 16 (Requirement 5-0127).
 - b. An alternative method may be proposed to the LBO for approval provided:
 - i. An analysis that indicates the interaction effects of the unrestrained equipment²⁷ is acceptable at the DBE, or
 - ii. The equipment will be located in an essentially unoccupied area²⁸ and is protected as such through administrative or engineering control.
 - c. In an existing facility, unless the building is undergoing more than a limited structural alteration as defined in the IEBC (907.4.4 in 2015), it may be that restraint can be designed to lesser requirements; see Code of Record/Structural discussion in ESM Ch. 16 (*Sect. IBC-GEN Att. B., 301.1, which specifically addresses anchorage*).

NOTE for Equipment Outside: Both of the above criteria also apply outside of a building; if the above require an item to be restrained for wind and/or seismic were it inside, then restraint must either be provided or shown/proven unwarranted (Requirement 5-0128).

NOTE for Laboratory Equipment Inside: *Seismic restraint of lab equipment inside of a building can be achieved using the Safe-T-Proof Laboratory Equipment Anchorage Kit (STP-MP-203-09-ICC) in accordance with ICC ES ESR-4167 or other approved means.*

²⁶ Reasons related to performance, functionality, operability, etc. (e.g., motor, centrifuge, certain suspended items/systems, etc.)

²⁷ E.g., from rocking, swaying, overturning, sliding, impact, etc. Also: In all cases, equipment must be anchored if it is permanently attached to utility services (electricity, gas, and water). (ASCE 7 C13.1.1)

²⁸ I.e., incidental occupancy: occupied for a total of less than 2 hours/day, yearly average (RP 8 exemption 1.3.d utilized herein). Not the same as *incidental use* (IBC sec. 509 term relating to certain adjunct uses).